

# **Health Impacts of Biomass**

## ***Historical Reconstruction of Health Impacts of Energy Use***

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# Issues and Impacts of Energy

*Magnitude of impact and distribution both matter*

- Climate change
- Air pollution
- Water pollution
- Land use
- Material use
- Toxic chemicals
- The list goes on....



# Benefits of Energy

*Magnitude and distribution of benefits also matter*

- Heating and cooking
- Transportation
- Computer and internet use
- Manufacturing & Construction
- Agriculture
- This list also goes on...



# Reductions in the Health Burden of Energy

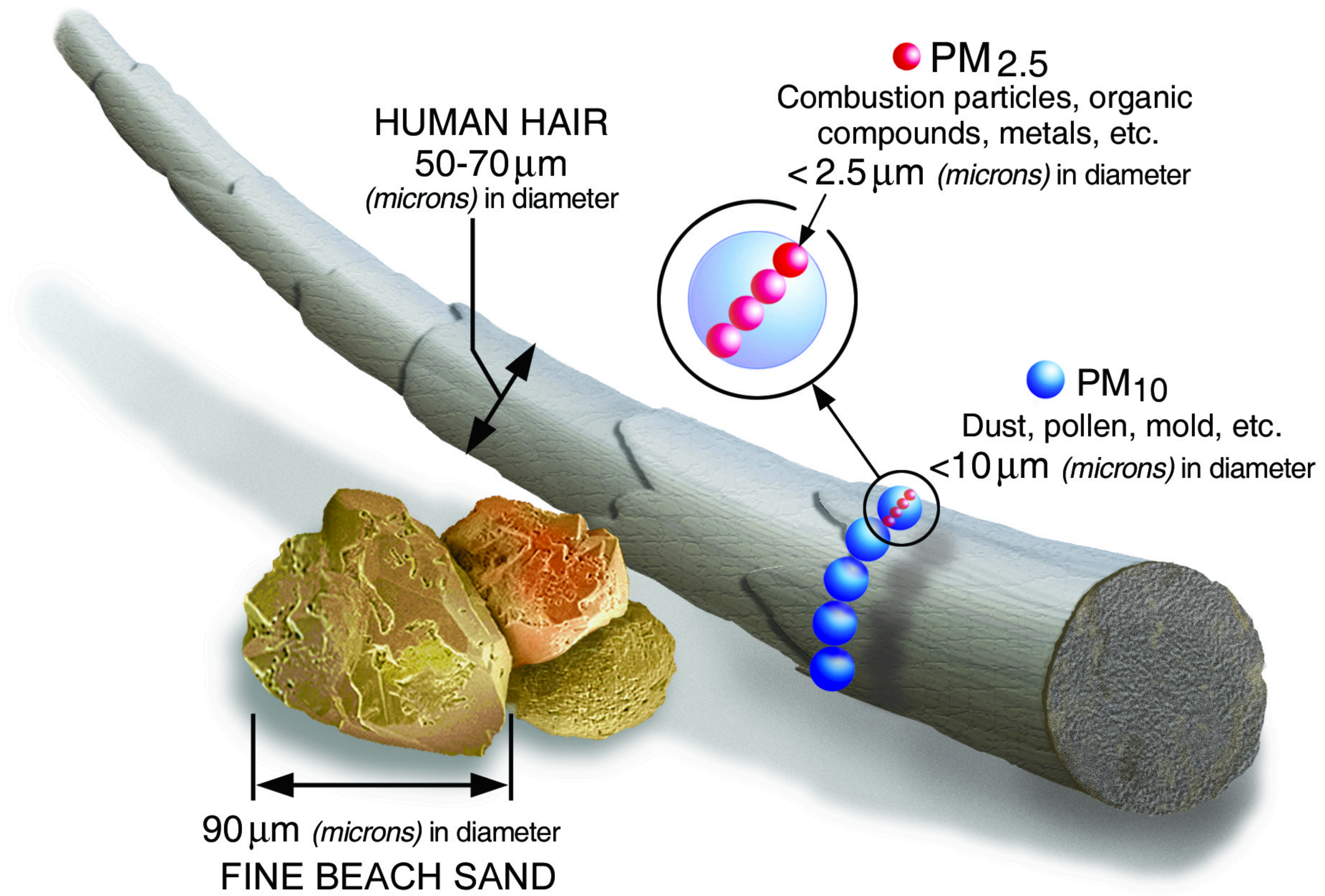
*Historical Reconstruction of the U.S. Transition away from Coal*

## Decreases in electrical generation CO<sub>2</sub> emissions due to transition from coal to gas since 2008

- What happened to health impacts of coal and gas?
- Health impacts of other fuels?
- What happened in other stationary sources, like buildings and industry?







**HUMAN HAIR**  
50-70  $\mu\text{m}$   
(microns) in diameter

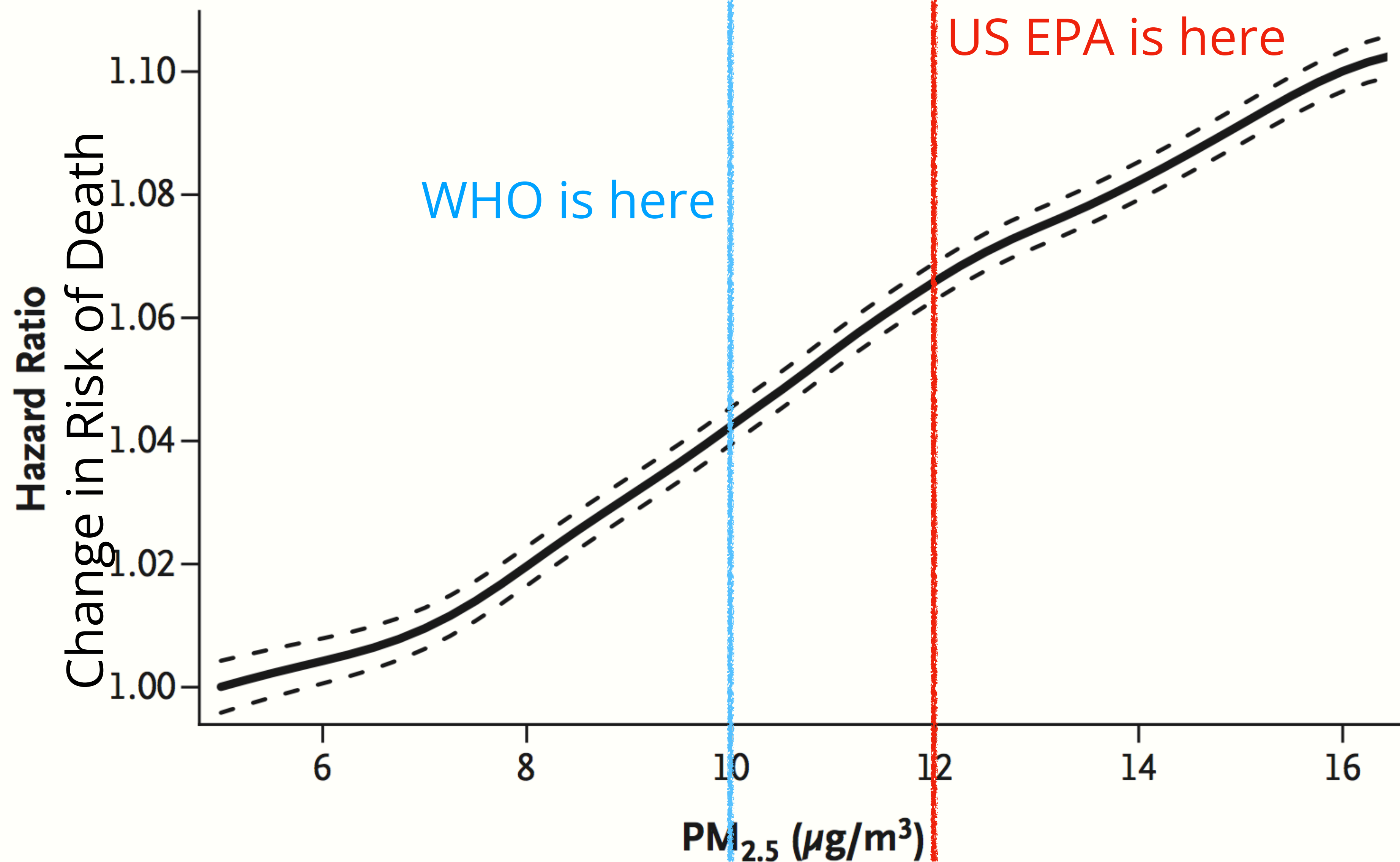
90  $\mu\text{m}$  (microns) in diameter  
**FINE BEACH SAND**

**PM<sub>2.5</sub>**  
Combustion particles, organic  
compounds, metals, etc.  
< 2.5  $\mu\text{m}$  (microns) in diameter

**PM<sub>10</sub>**  
Dust, pollen, mold, etc.  
< 10  $\mu\text{m}$  (microns) in diameter



# A Exposure to PM<sub>2.5</sub>





# Historical Reconstruction Model Framework

*Modeling change in U.S stationary source health impacts from 2008 to 2017*

***Historical  
changes in air  
pollutant  
emissions by:***

- Source Type
- Fuel Type
- 2008, 2011,  
2014, 2017

***Emissions***

***Reduced Complexity Models  
(RCMs) (EASIUR, InMAP, AP2/  
COBRA)***

- Total mortality impacts by  
source county for  $PM_{2.5}$
- Adjusted to more recent  
epidemiology on annual  $PM_{2.5}$   
and mortality risk (Vodonos et al.  
2018)

***Impact estimation model***

***Public Health Impacts***

*By:*

- Fuel types
- Sources
- Pollutants
- Years
- Inter-comparison  
between RCMs

***Results***

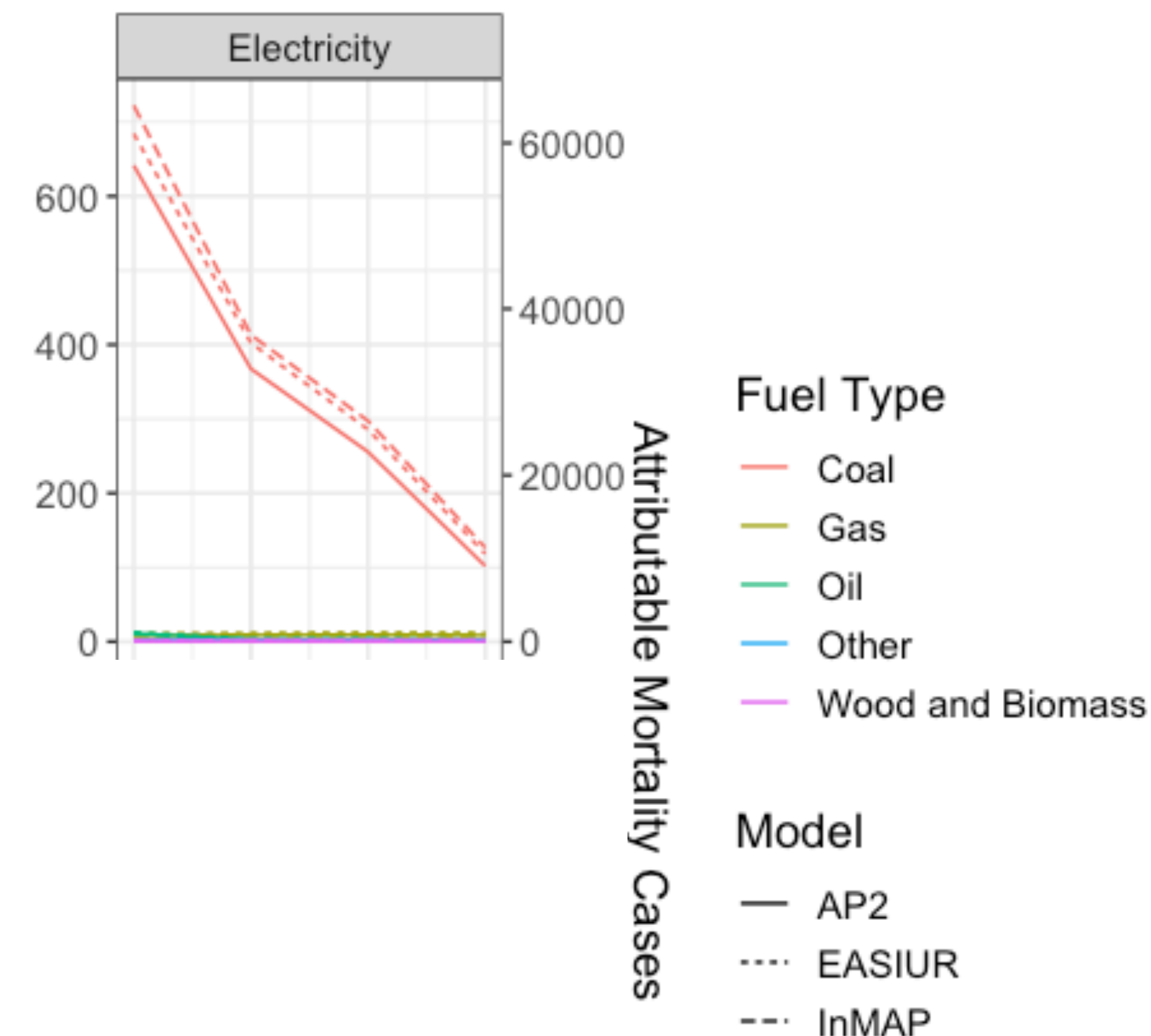


# Health Impacts Changed in the Last Decade

*Coal and oil replaced by gas and biomass*

- **Electricity:** 59-66k in 2008 to 10-12k in 2017
- **Industrial Boilers:** 37-42k in 2008 to 22-29k in 2017
- **Commercial Buildings:** 4.2-5.9k in 2008 to 2-3.5k in 2017
- **Residential Buildings:** 22-29k in 2008 to 15-20k in 2017

Mortality Impacts (Billion \$ (2017 USD))

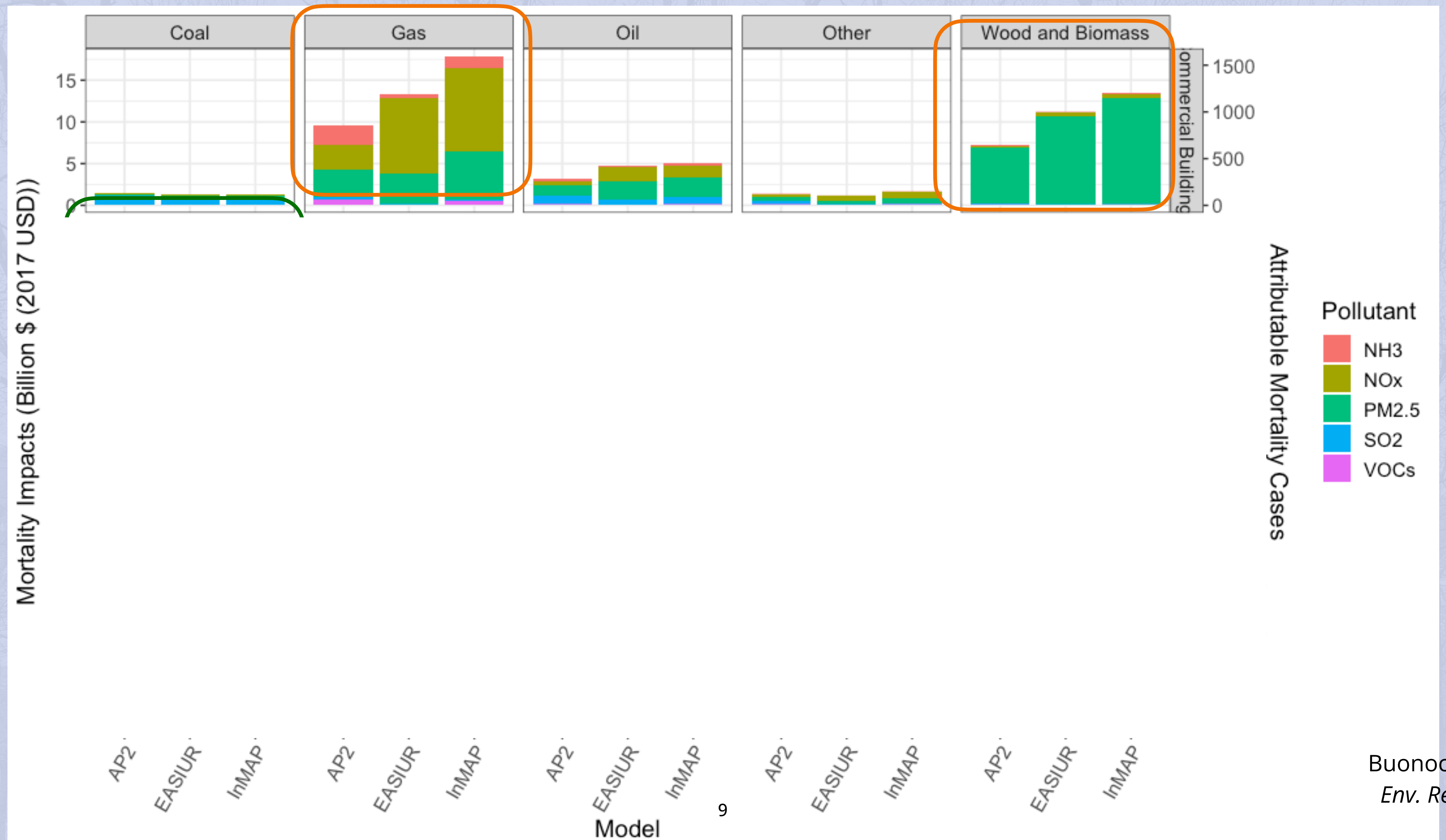


Year



# 2017 – Impacts Now Driven by a Mix of Fuels and Pollutants

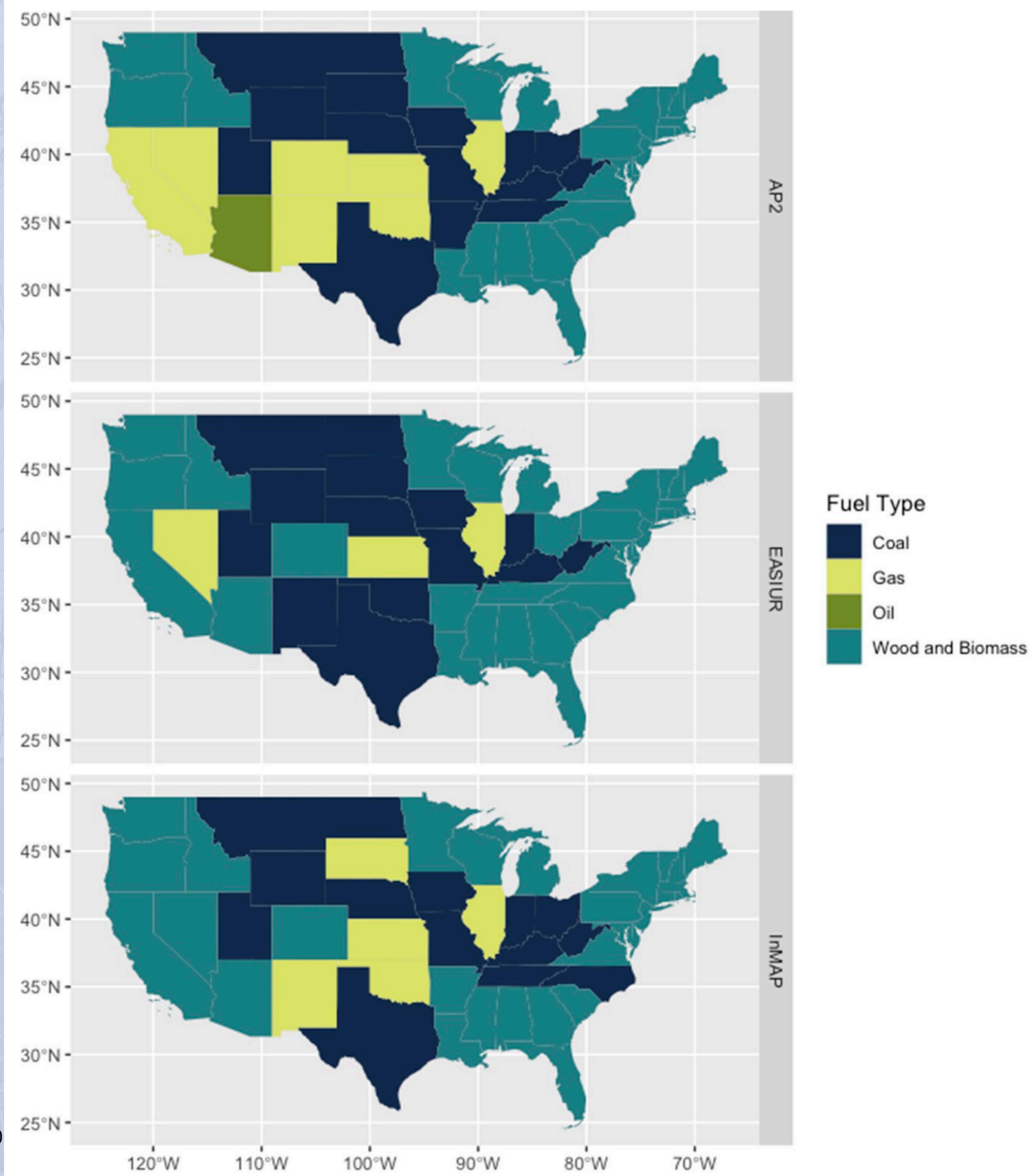
*Coal, gas, and wood/biomass – SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>2.5</sub>, and NH<sub>3</sub>*



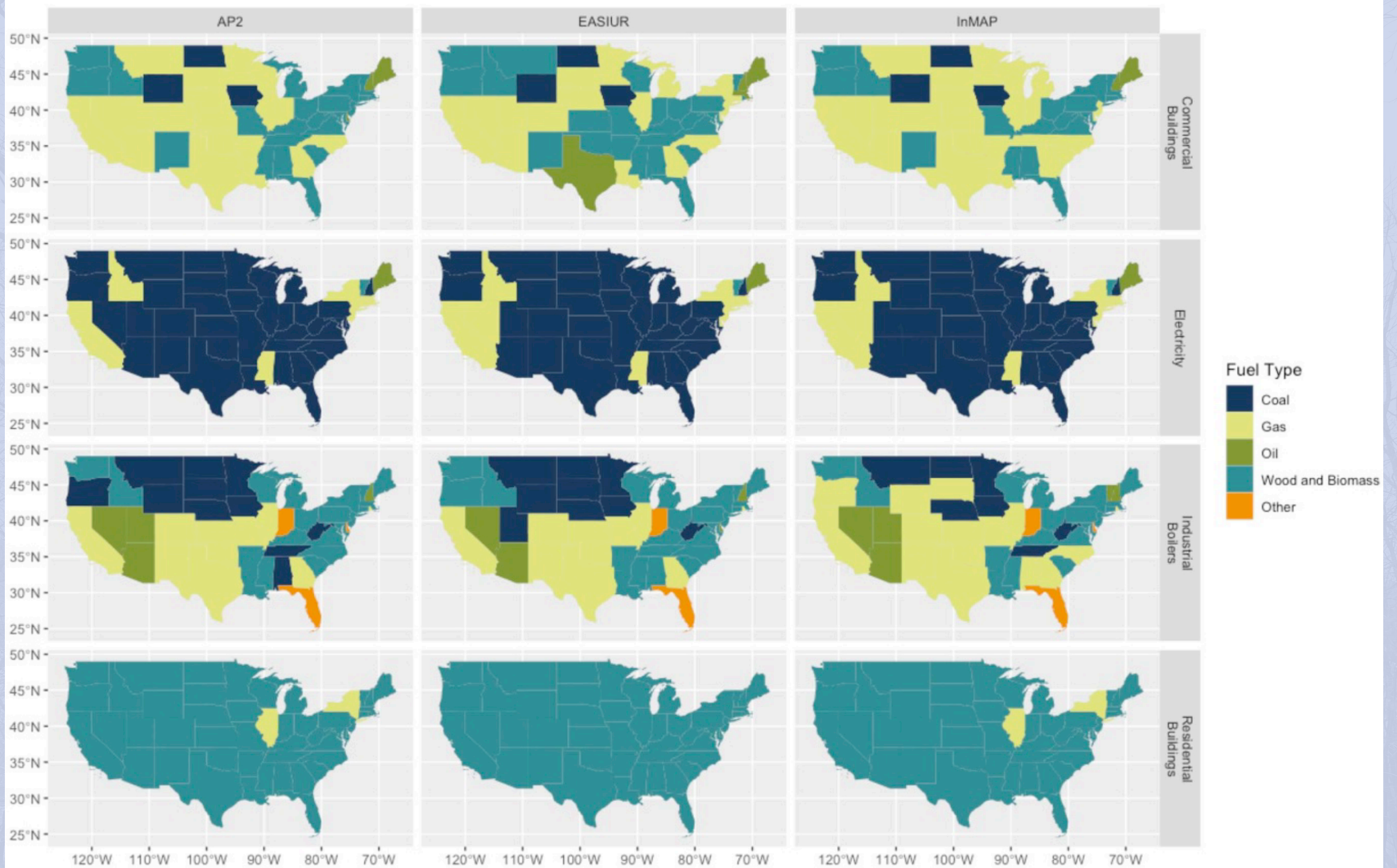


# Variation Across the U.S.

- Good agreement across models (differences due to assumptions about baseline, treatment of chemistry, and meteorology year)
- Wood and biomass most impactful fuel in nearly half of U.S. (across all energy uses)





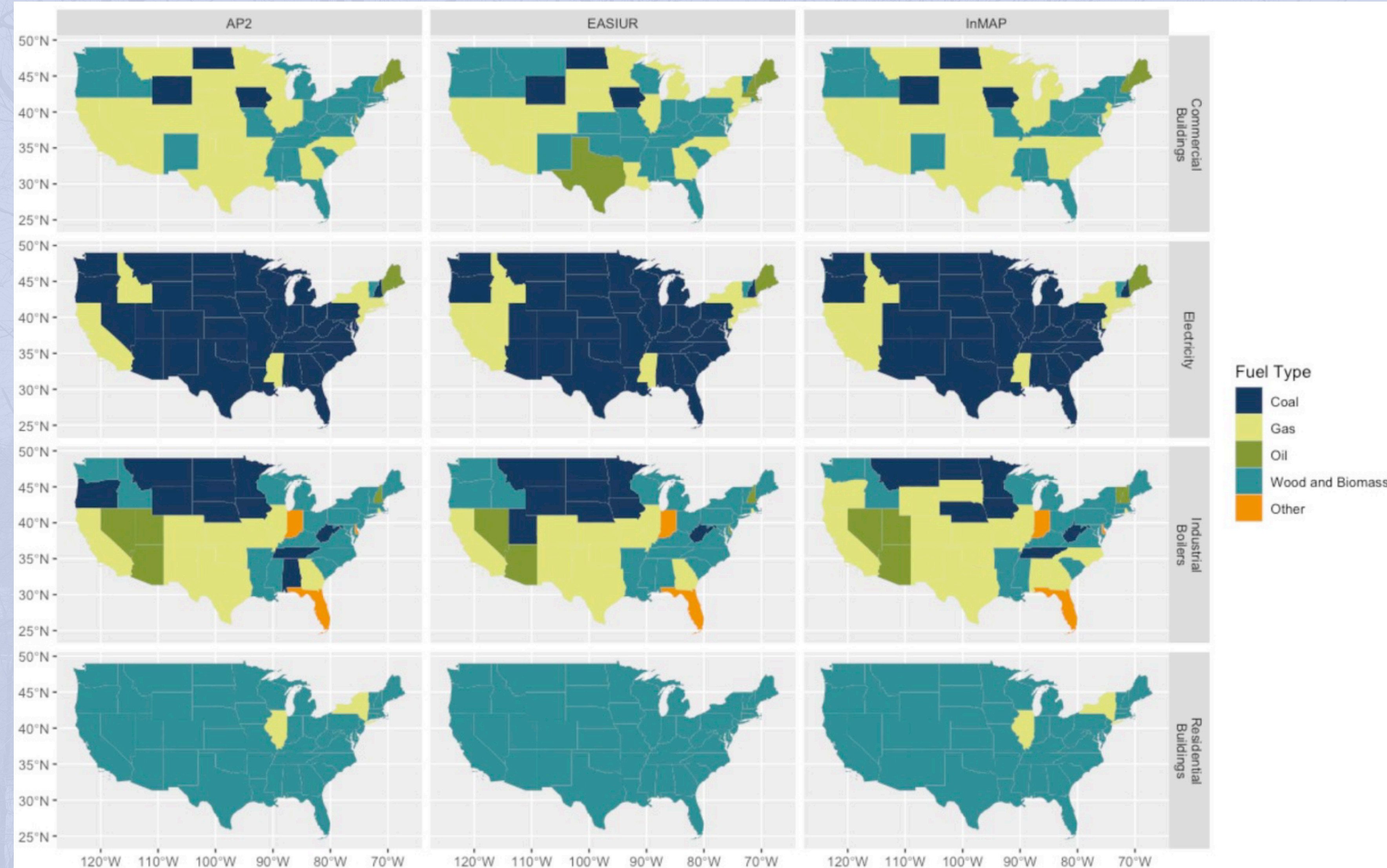




# Impacts by Sector

2017

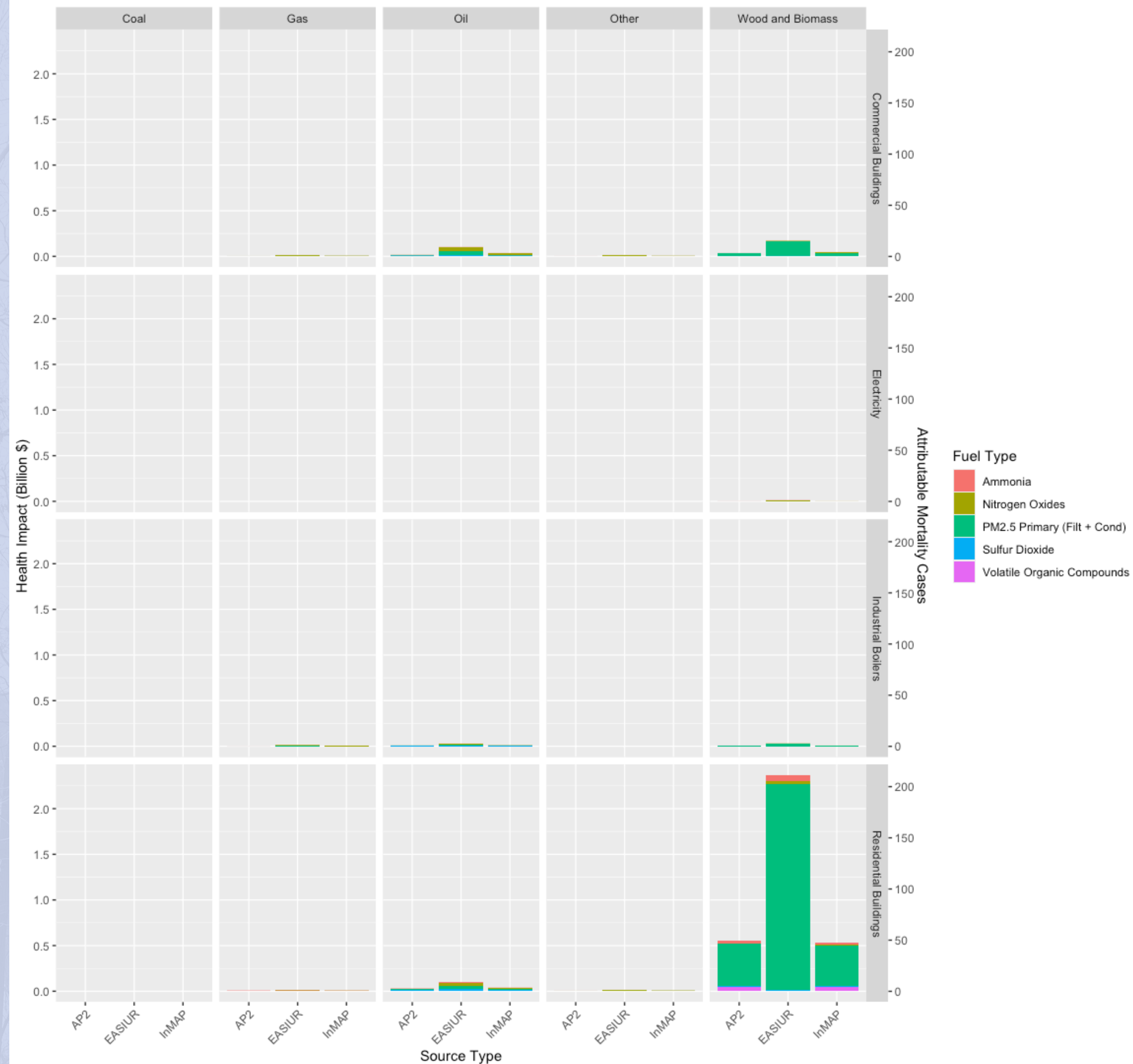
- Biomass is most impactful in VT across all sectors
- Each sector has own leading fuel





# Vermont

- Biggest impacts from residential wood
- Second biggest from oil
- Little gas, coal, or other

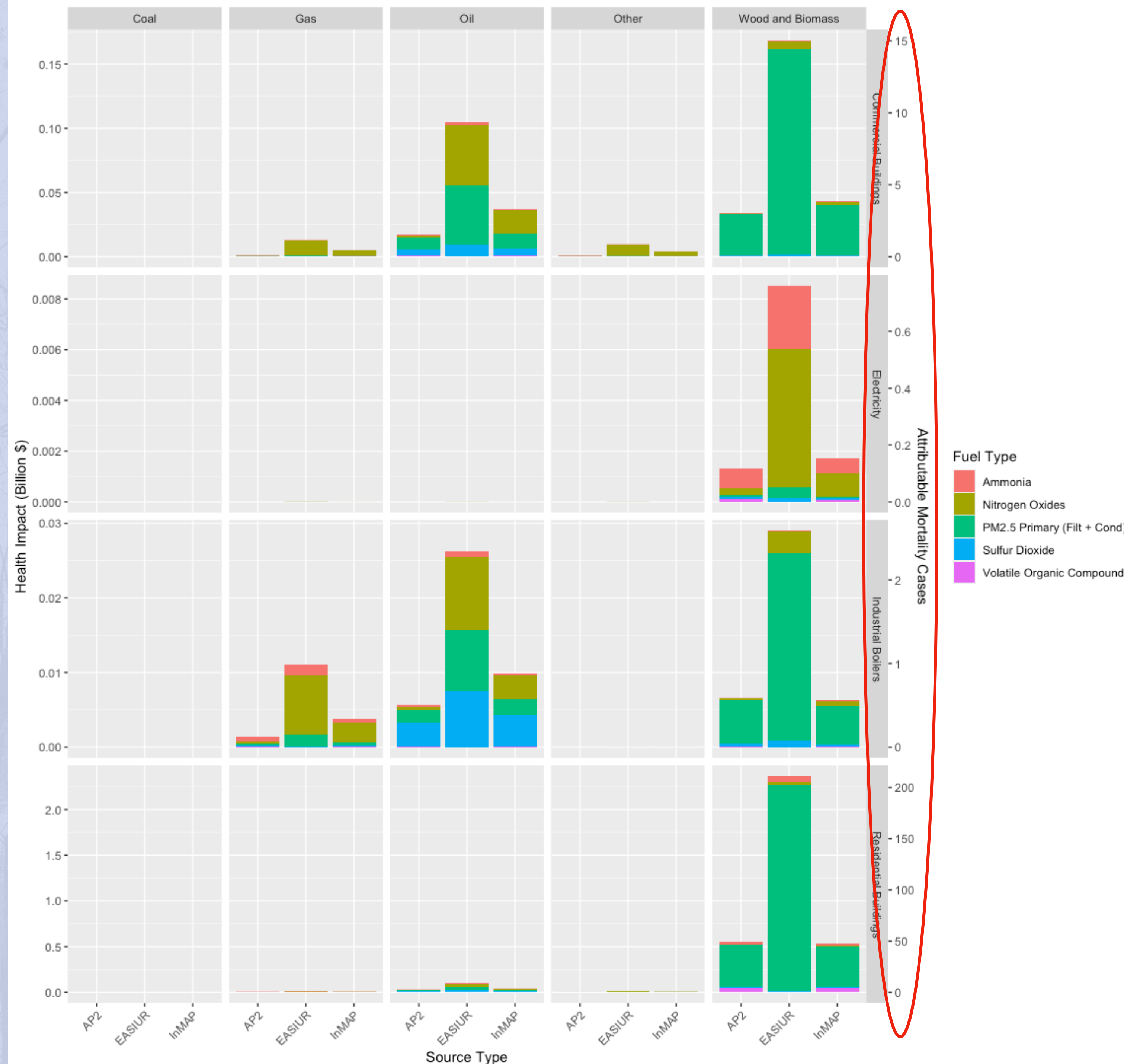




# Vermont

## *Adjusting axis labels*

- Biomass is biggest impact for electricity
- Commercial buildings #2, followed by industrial boilers





# Limitations

- Only mortality from PM<sub>2.5</sub> – does not include ozone, NO<sub>2</sub>, ultra fine particles, or indoor exposures
- No information on where impacts are occurring
- Not suitable for EJ and equity assessment
- Changing emissions factors over time
- Not a true life cycle comparison of fuels



# Main Conclusions

- Biomass and wood are not health neutral fuels (even if they are GHG neutral)
- Fuel types have more or less equal impacts nationwide, previously coal-dominated
- Dominant sources have switched from point sources to mix of point and area/non-point



***Thank you!***